

GEOL: CHAPTER 14

The Work of Wind and Deserts



Learning Outcomes

- LO1: Discuss the role wind plays in transporting sediment
- LO2: Explain the two processes of wind erosion
- LO3: Identify the different types of wind deposits
- LO4: Describe air-pressure belts and global wind patterns
- LO5: Describe the distribution of deserts
- LO6: Identify the various characteristics of deserts
- LO7: Identify the different types of desert landforms



Desertification

- The expansion of deserts into formerly productive lands
- Human agriculture has altered natural vegetation patterns
- Understanding deserts is important for society
 - Australia
 - Sahara
 - Population growth in California, Nevada, Arizona
 - Climate change

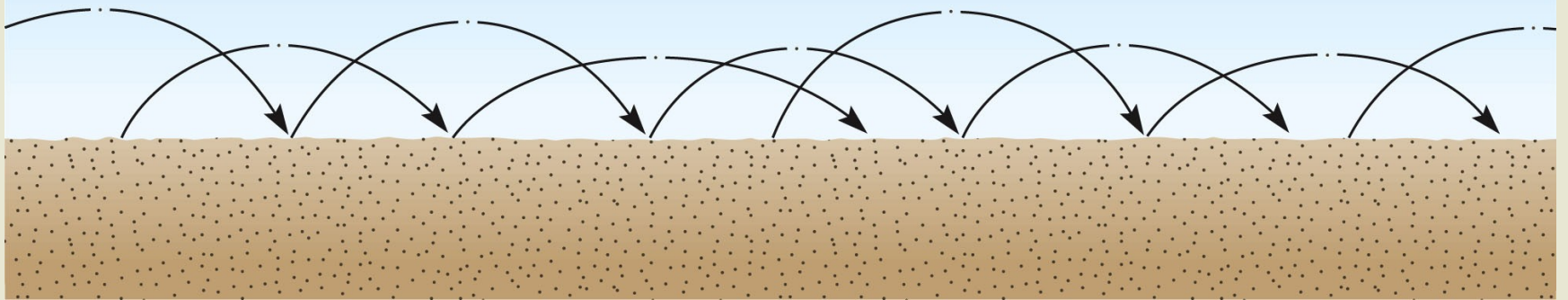
Wind Sediment Transport

- Wind is less dense than water, so can only transport smaller sediments
- Bed load: moves by saltation or by rolling or sliding
- Saltation: wind lifts sand grains that dislodge other grains upon hitting the surface

Wind



Loose sand
surface



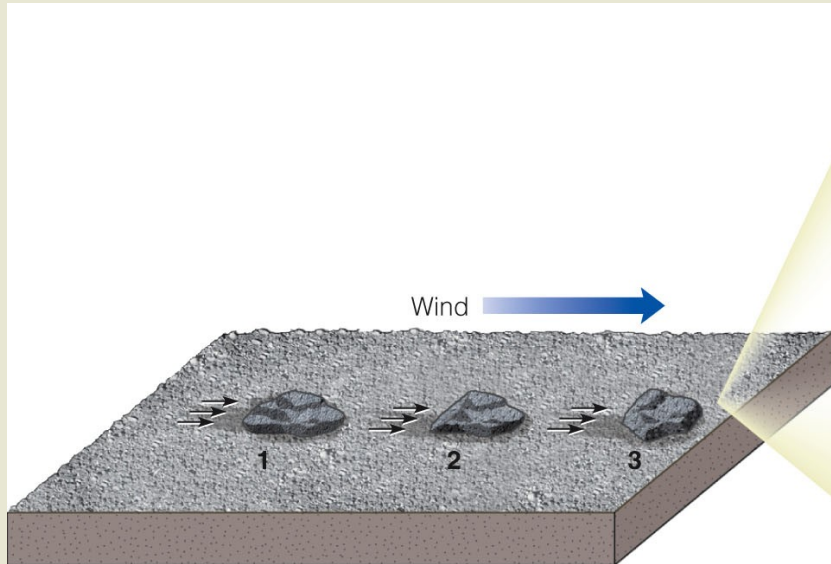
Wind Sediment Transport (cont.)

- Suspended load:
 - Silt- and clay-sized particles
 - Will usually stay at surface unless physically disturbed
 - Once in the air, smaller particles can travel thousands of miles



Wind Erosion: Abrasion

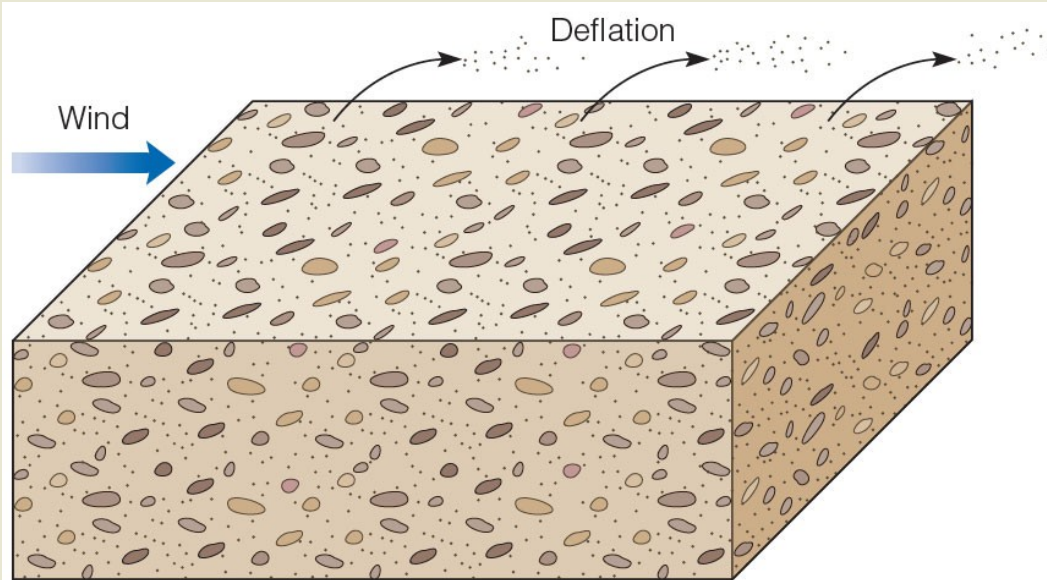
- Caused by saltating sand grains
- Analogous to sandblasting
- Rarely more than a meter above ground
- Typically modifies existing features
- Ventifacts: surfaces altered by windborne particles



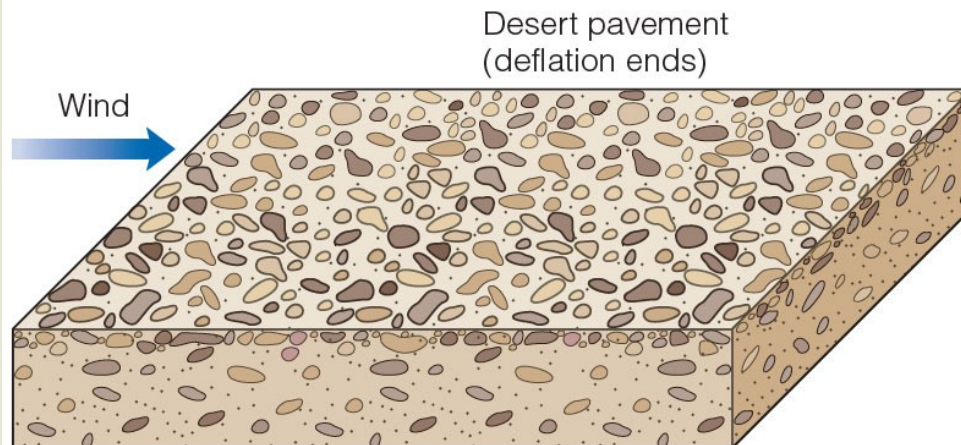
Wind Erosion: Deflation

- Removal of loose surface sediment by wind
- Deflation hollows/blowouts from differential erosion
- Desert pavement: close-fitting pebbles and cobbles caused by wind eroding away smaller particles

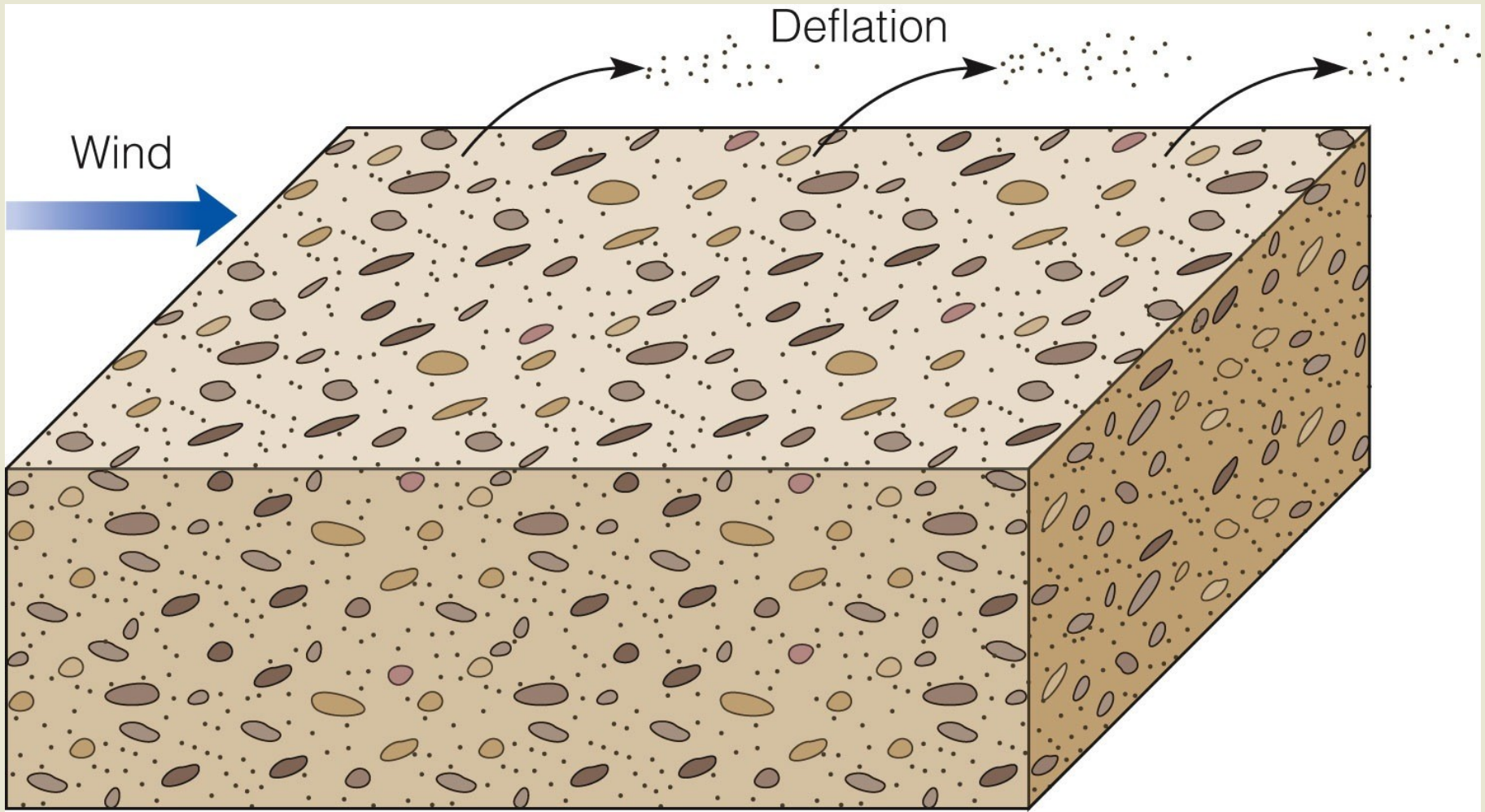




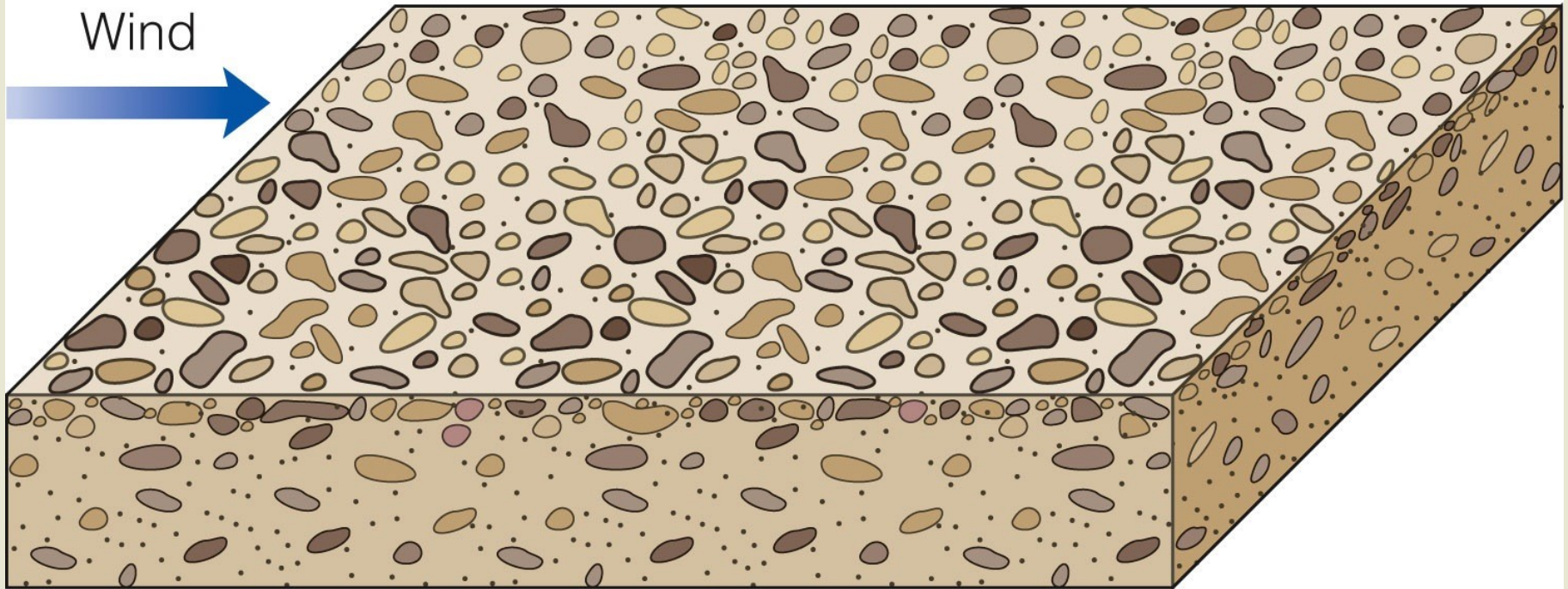
a. Fine-grained material is removed by wind,



b. leaving a concentration of larger particles that form desert pavement.



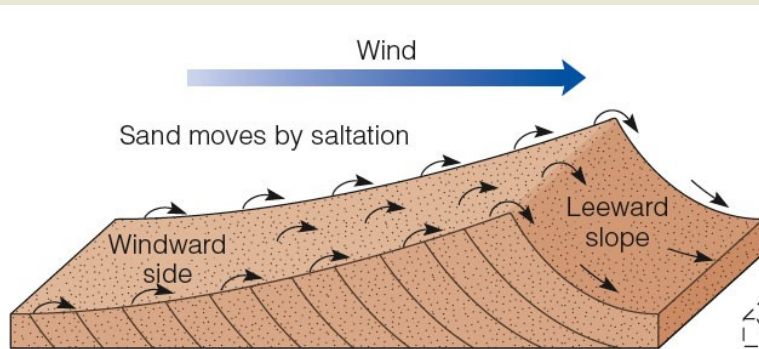
Desert pavement (deflation ends)



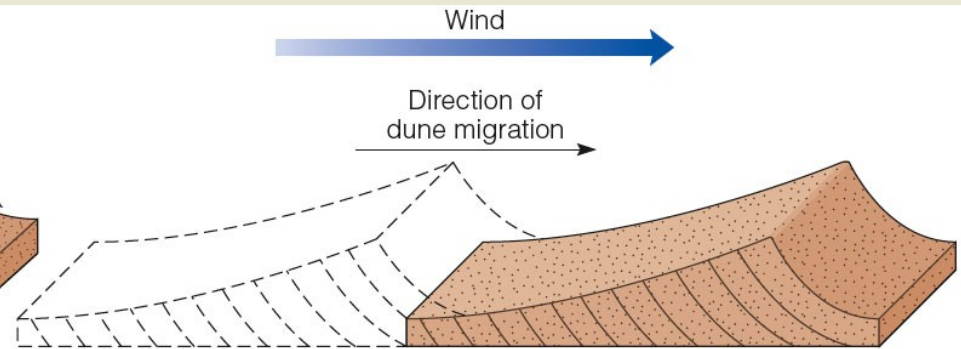
Dune Formation

- Mound or ridge of wind-deposited sand
- Form around an obstruction that stops sand grains
- Shallow windward slope
- Steep leeward slope: angle of repose
- Dune can migrate in direction of strong prevailing winds

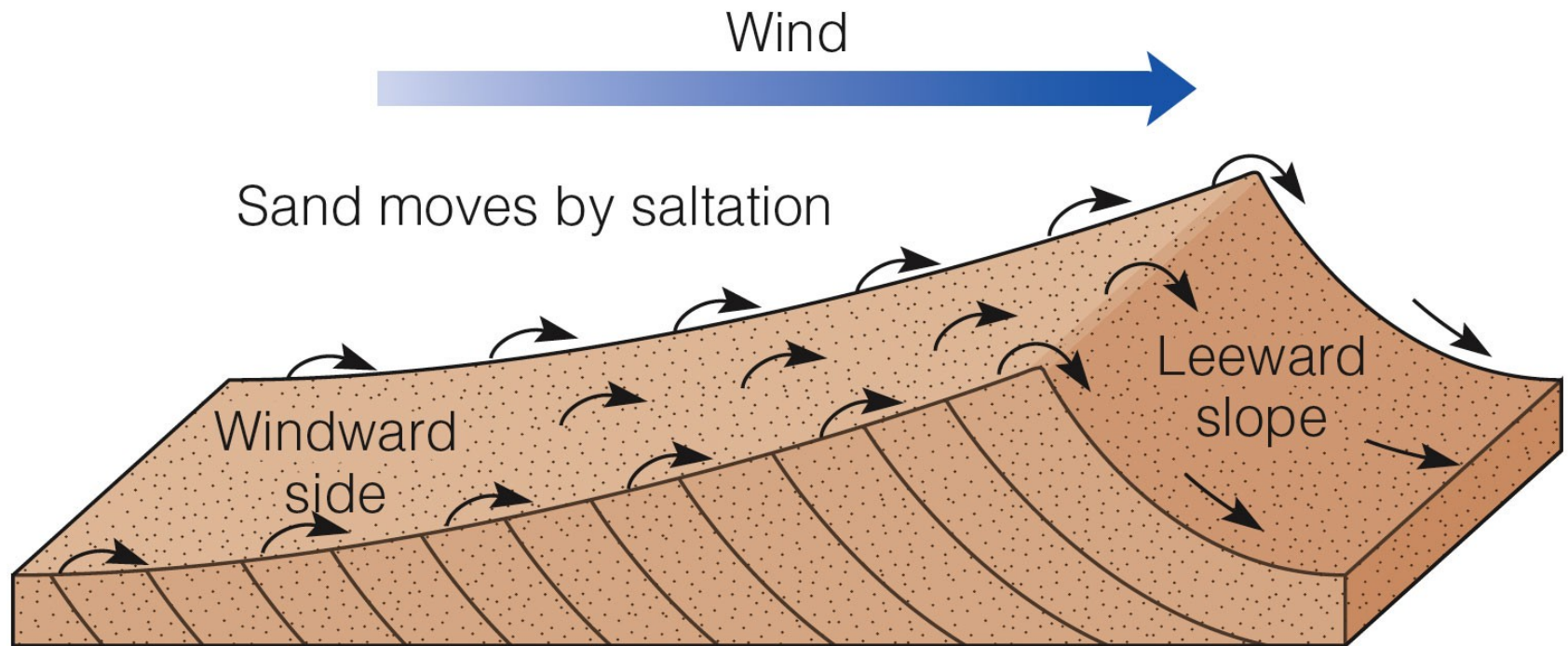




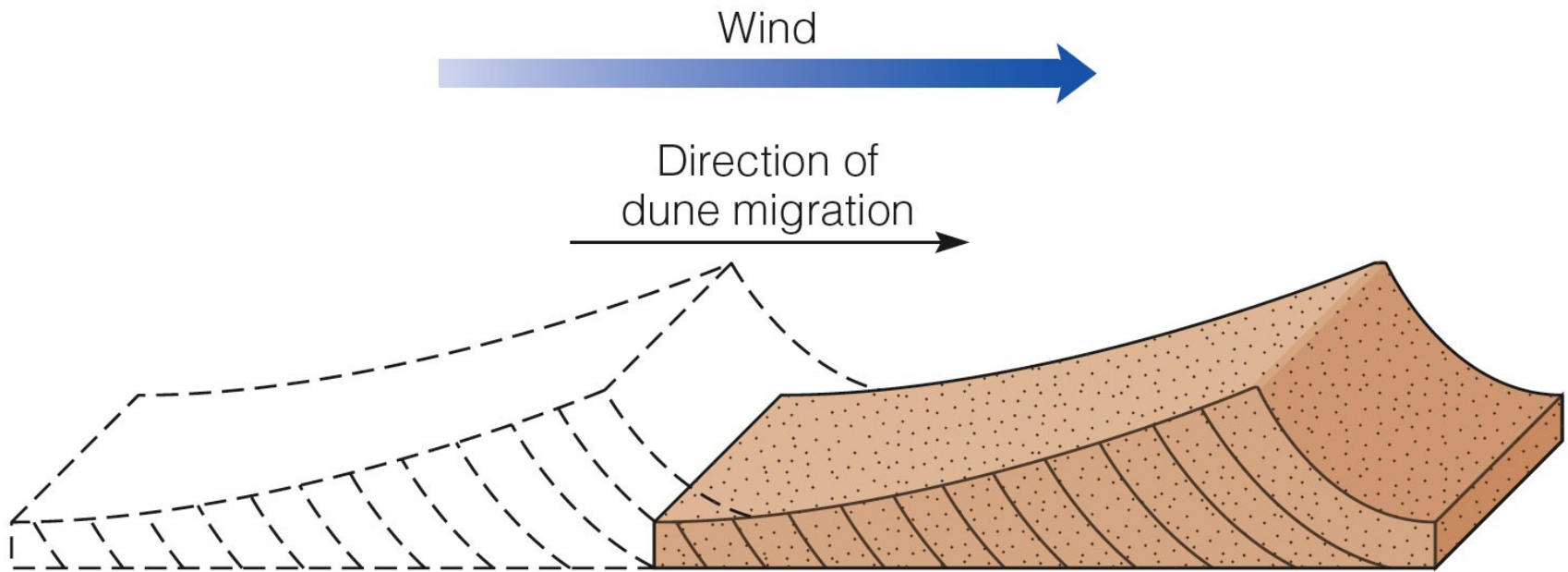
a. Profile of a sand dune.



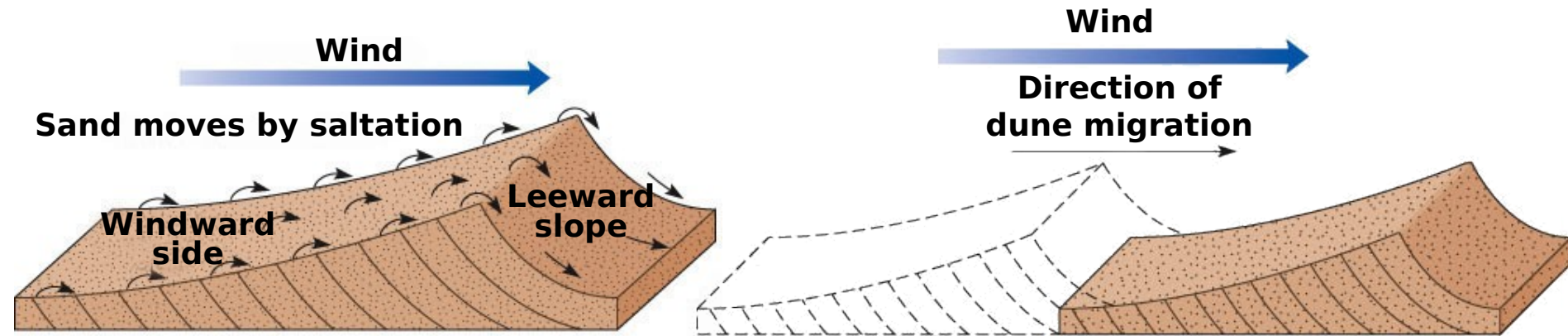
b. Dunes migrate when sand moves up the windward side and slides down the leeward slope. Such movement of the sand grains produces a series of cross-beds that slope in the direction of wind movement.



a. Profile of a sand dune.



b. Dunes migrate when sand moves up the windward side and slides down the leeward slope. Such movement of the sand grains produces a series of cross-beds that slope in the direction of wind movement.



a. Profile of a sand dune.

b. Dunes migrate when sand moves up the windward side and slides down the leeward slope. Such movement of the sand grains produces a series of crossbeds that slope in the direction of wind movement.

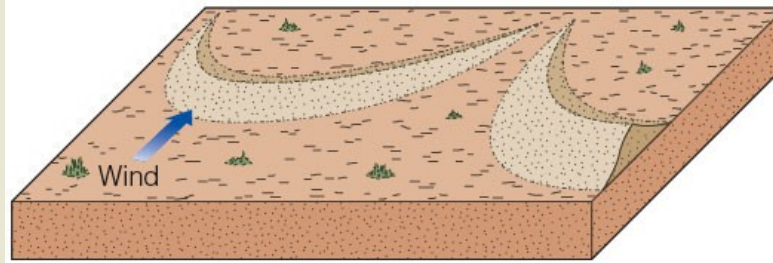


Dune Types

1. Barchan
2. Longitudinal
3. Transverse
4. Parabolic
 - Determined by:
 - Sand supply
 - Wind direction and velocity
 - Amount of vegetation

Barchan Dunes

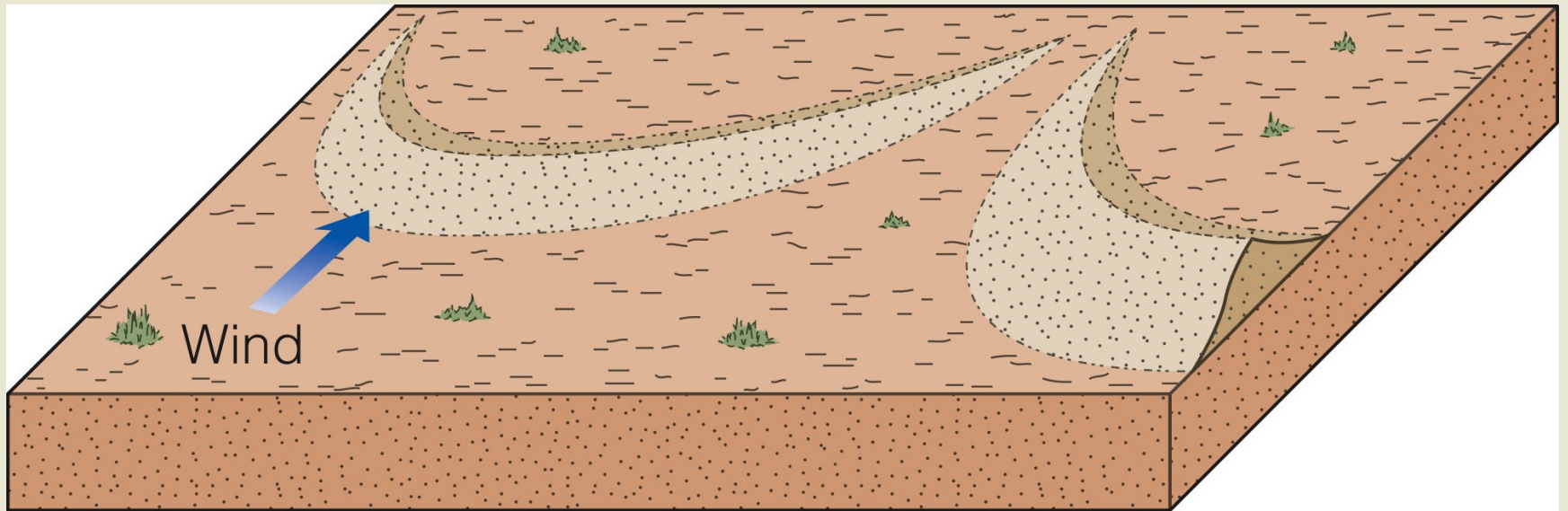
- Crescent shaped, tips point downwind
- Form in areas with a flat, dry surface
- Little vegetation
- Nearly constant wind direction
- Mobile – can move 10+ meters per year
- Up to 30 meters high



a. Barchan dunes form in areas that have a limited amount of sand, a nearly constant wind direction, and a generally flat, dry surface with little vegetation. The tips of barchan dunes point downward.



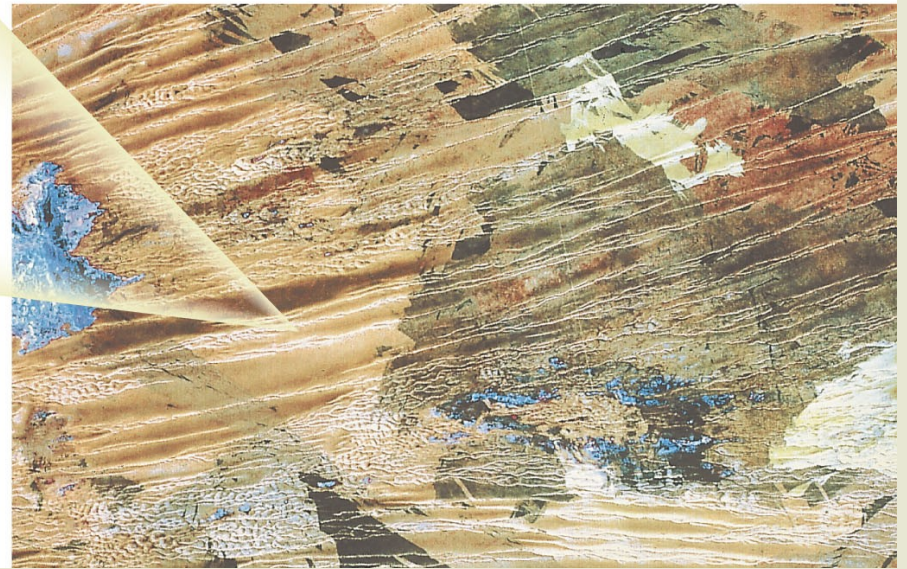
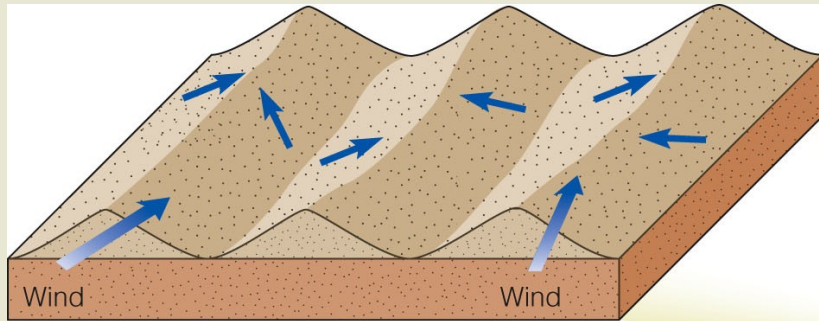
b. A ground-level view of several barchan dunes.





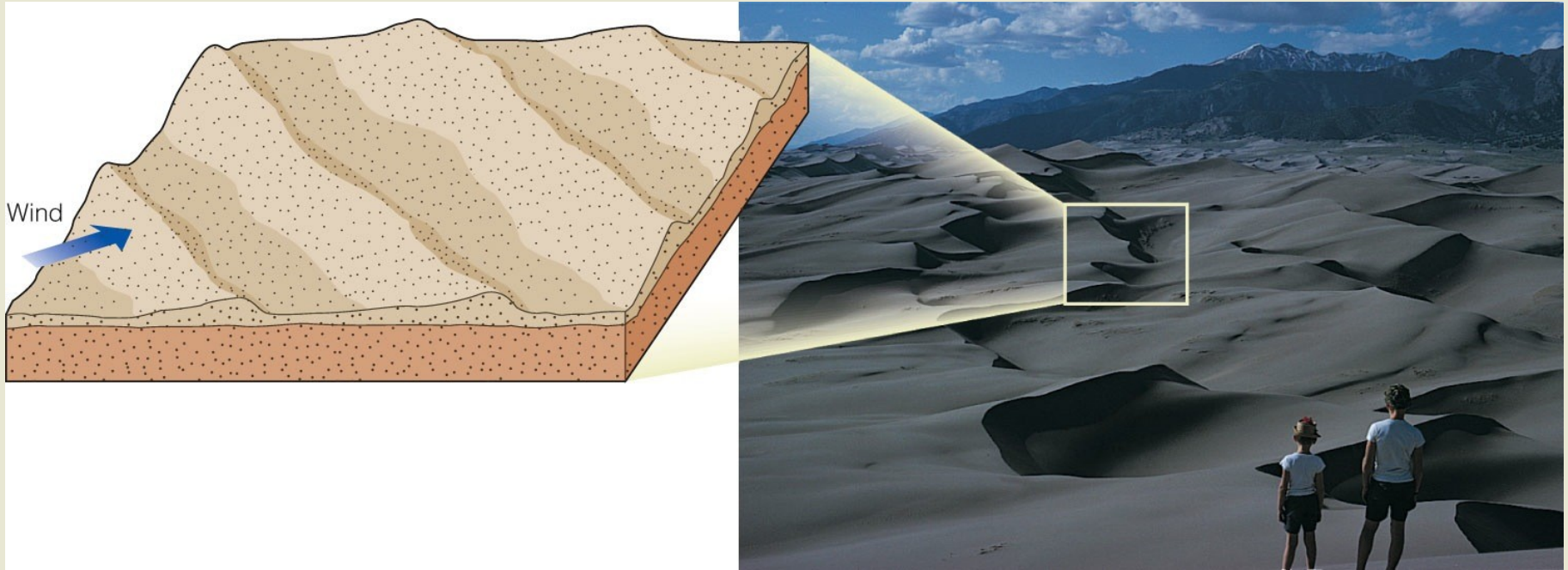
Longitudinal Dunes

- Long parallel ridges of sand that are parallel to prevailing winds
- Limited sand supply
- Winds converge from slightly different directions
- 3-100 meters in height
- Up to 100 km long
- Cover extensive areas of Australia, Saudi Arabia, Egypt, Iran



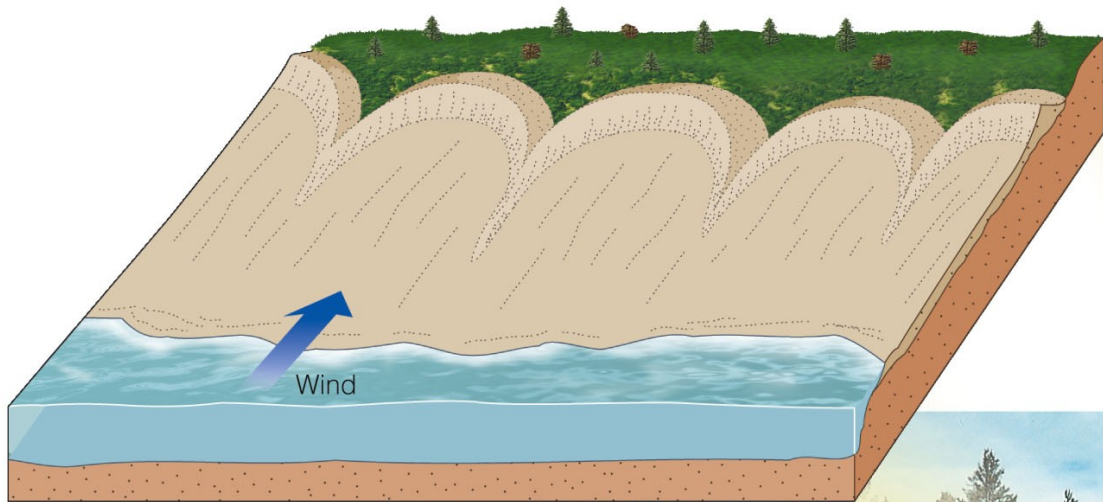
Transverse Dunes

- Long ridges perpendicular to prevailing wind direction
- Abundant sand with little or no vegetation
- “Sand seas”
- Up to 200 meters high
- Up to 3 km wide



Parabolic Dunes

- Common in coastal areas
- Abundant sand
- Strong onshore winds
- Form where vegetation cover is broken, from a deflation hollow or blowout
- Tips point upwind



Loess

- Wind-blown silt and clay deposits
- Quartz grains, feldspar, micas, calcite
- Three sources:
 - Deserts
 - Pleistocene glacial outwash deposits
 - River floodplains in semiarid regions

Loess (cont.)

- Easily eroded
- Steep cliffs and rapid stream erosion
- 10% Earth surface
- 30% U.S. surface
- Fertile soils



Global Air-Pressure Belts

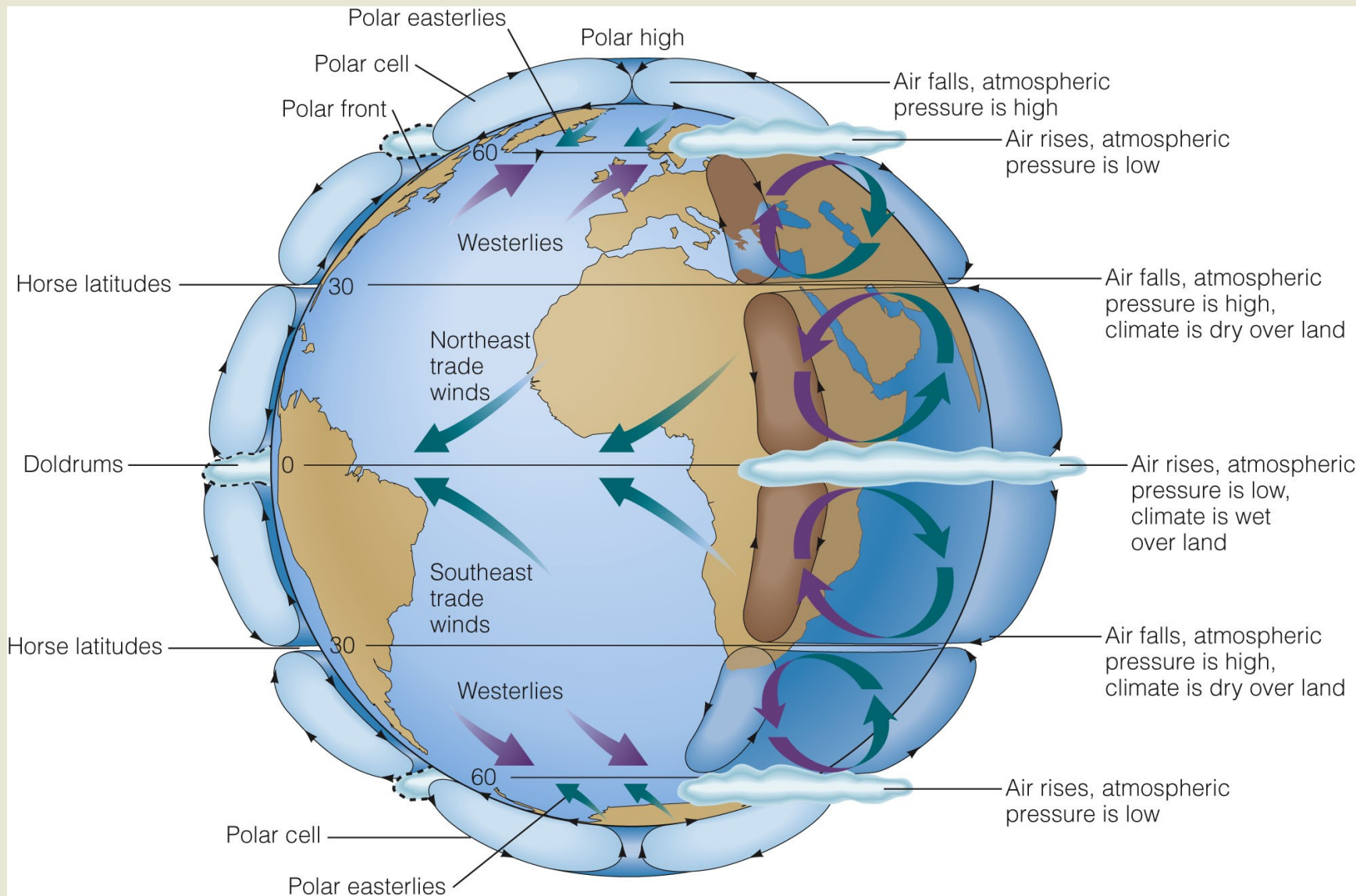
- Air pressure: density of air exerted on surroundings (weight)
- Heated air = lower surface air pressure; much solar heating
- Cooler air = higher surface air pressure; less solar heating

Global Air-Pressure Belts (cont.)

- Equatorial zone receives most solar energy
- Surface air rises, cools, releases moisture
- Rising air is drier as it moves poleward
- At 20-30 degrees latitude, it sinks, compresses, and warms to form a high-pressure area conducive to deserts

Global Wind Patterns

- Winds: air flows from high-pressure areas to low-pressure areas
- Coriolis effect: apparent deflection of moving objects because of Earth's rotation
 - Winds deflected to the right in the Northern Hemisphere
 - To the left in the Southern Hemisphere

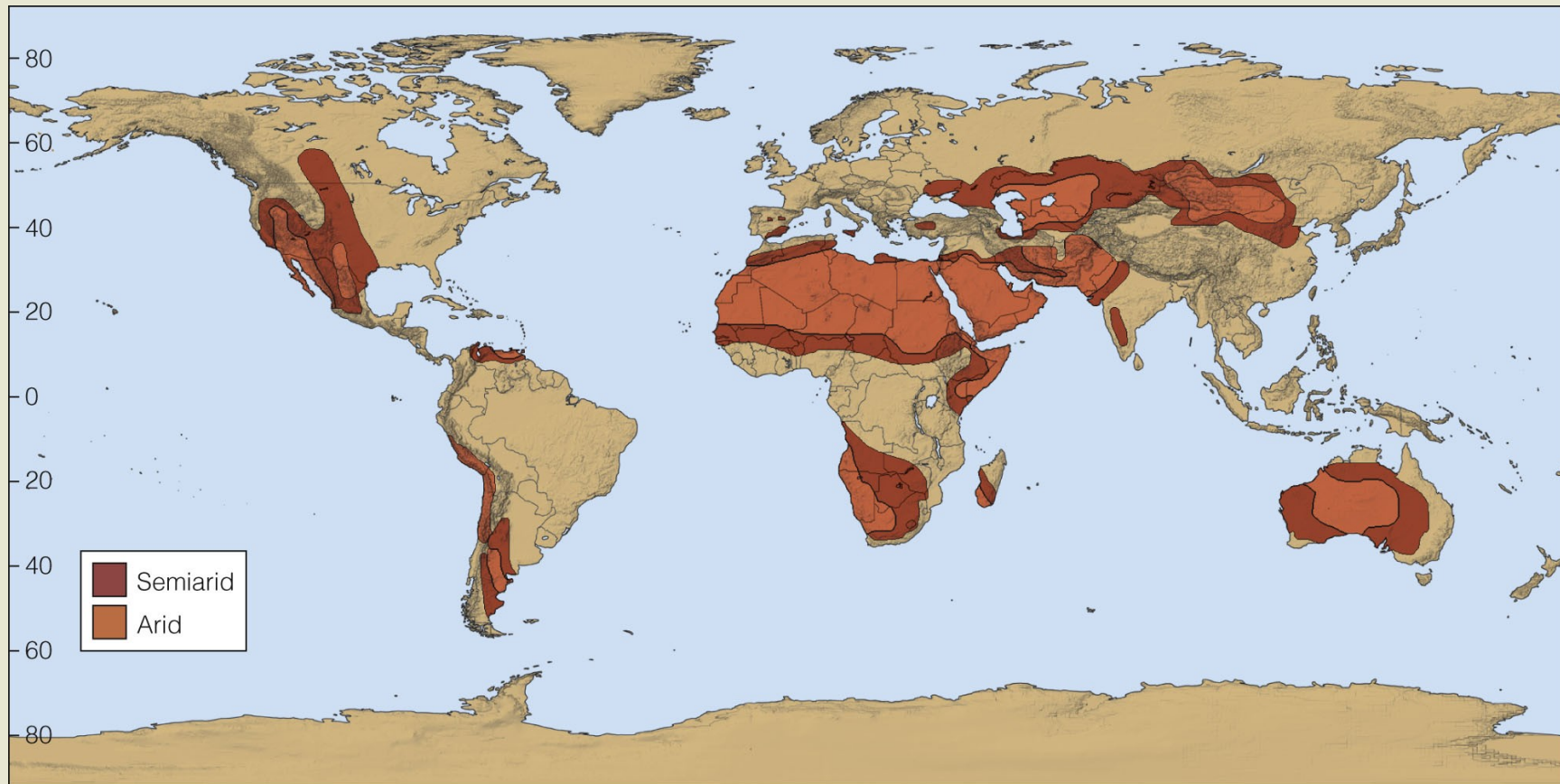


Distribution of Deserts

- 30% of land surface
- Low and middle latitudes
- Potential evaporation greater than yearly precipitation
- Semiarid: more precipitation than arid

Distribution of Deserts (cont.)

- Arid = desert
- Deserts
 - Less than 25 cm precipitation per year
 - High evaporation rates
 - Poorly developed soils
 - Mostly devoid of vegetation



Climate Characteristics of Deserts

- Hot summer days: 32°C – 50°C
- Cooler on winter days: 10°C – 18°C
- Precipitation variable and unpredictable
- Plants are small, widely spaced, grow slowly
 - Hard, waxy stems and leaves minimize water loss



Weathering and Soils

- Mechanical weathering dominates
 - Temperature fluctuations
 - Frost wedging
- Some chemical weathering, though minor
- Desert soils are thin, patchy and subject to erosion

Desert Streams

- Running water causes most erosion in deserts
- Most precipitation comes from brief and heavy cloudbursts
- Rapid runoff quickly fills channels, with rapid sediment transport and much erosion
- Most streams flow intermittently and don't reach the sea (internal drainage)
- Some permanent streams: e.g., Colorado, Nile, Niger, Rio Grande rivers

Playa Lakes

- Excess water from rainstorms accumulates in low-lying areas
- Temporary: hours to months
- Shallow and saline water
- Evaporates to leave a playa (salt pan)



a. A playa lake formed after a rainstorm near Badwater, Death Valley National Park, California. Playa lakes are ephemeral features, lasting from a few hours to several months.



b. Salt deposits and salt ridges cover the floor of this playa in the Mojave Desert, California. Salt crystals and mud cracks are characteristic features of playas.

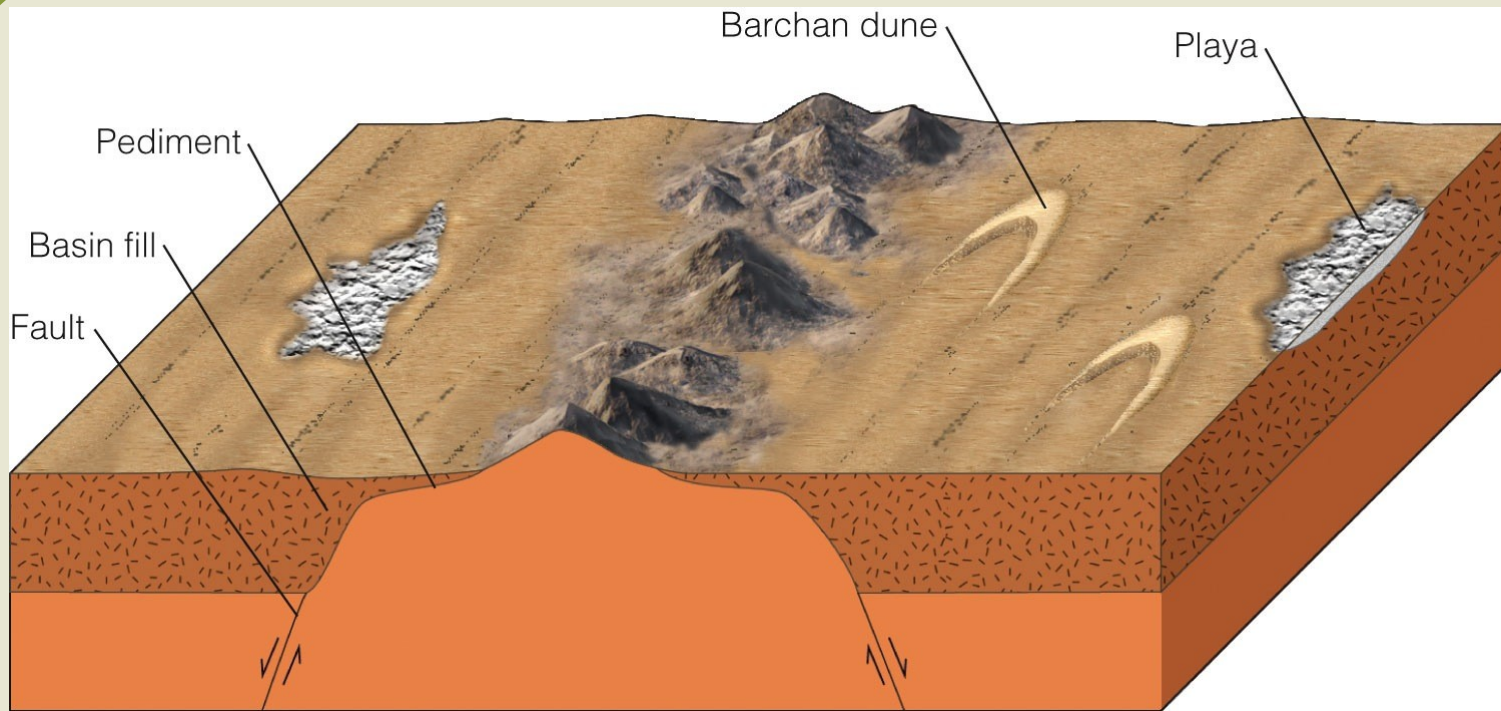




Alluvial Fans and Pediments

- Sediment-laden streams leave mountains and create fan-shaped sediment deposit on flat desert areas
- Common in the Basin and Range province in western North America
- Pediment: an erosion surface of low relief gently sloping away from a mountain range





Mesas and Buttes

- Mesa: broad and flat-topped; erosional remnant bounded by steep slopes
- Butte: mesa eroded into a pillar-like structure
- Both have an erosion-resistant cap rock underlain by more easily eroded rock



Virtual Field Trip

- The effects of wind erosion
- The features of wind deposition
- Desert landforms







